

## Determining the Percentage Composition.

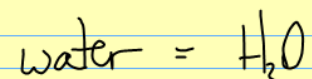
Over 300 years ago chemists defined the Law of Constant Composition. It states that the composition of a compound is a fixed ratio by mass of the elements in the compound. The Law of Constant Composition is the basis for determining the percentage composition of a compound. The percentage composition is the percentage by mass of each element present in a compound.

To calculate a percentage composition we start with the chemical formula. We then determine the mass of each element in 1 mole of the compound as well as the total mass. Then we calculate the percentage of the total mass for each element.

Example #1: Calculate the percentage composition of water.

Solution:

Assume there is 1 mol of water



$$m_{\text{H}} = 2 \text{ mol} (M_{\text{H}}) = 2 \text{ mol} (1.01 \text{ g/mol}) = 2.02 \text{ g H}$$

$$m_{\text{O}} = 1 \text{ mol} (M_{\text{O}}) = 1 \text{ mol} (16.00 \text{ g/mol}) = 16.00 \text{ g O}$$

$$m_{\text{H}_2\text{O}} = m_{\text{H}} + m_{\text{O}} : 2.02 \text{ g} + 16.00 \text{ g} = 18.02 \text{ g}.$$

$$\% \text{H} = \frac{2.02 \text{ g}}{18.02 \text{ g}} \times 100\% = 11.2\%$$

$$\% \text{O} = \frac{16.00 \text{ g}}{18.02 \text{ g}} \times 100\% = 88.8\%$$

$\therefore$  the percentage composition is 11.2% hydrogen and 88.8% Oxygen.

Example #2: Determine the percentage composition of sodium carbonate,  $\text{Na}_2\text{CO}_3$ .

Solution: Assume there is 1 mole of  $\text{Na}_2\text{CO}_3$ .

$$m_{\text{Na}} = 2 \text{ mol}(M_{\text{Na}}) = 2 \text{ mol}(22.99 \text{ g/mol}) = 45.98 \text{ g}$$

$$m_{\text{C}} = 1 \text{ mol}(M_{\text{C}}) = 1 \text{ mol}(12.01 \text{ g/mol}) = 12.01 \text{ g}$$

$$m_{\text{H}} = 3 \text{ mol}(M_{\text{O}}) = 3 \text{ mol}(16.00 \text{ g/mol}) = 48.00 \text{ g}$$

$$M_{\text{Na}_2\text{CO}_3} = 45.98 \text{ g} + 12.01 \text{ g} + 48.00 \text{ g} = 105.99 \text{ g}$$

$$\% \text{Na} = \frac{45.98 \text{ g}}{105.99 \text{ g}} \times 100\% = 43.4\%$$

$$\% \text{C} = \frac{12.01 \text{ g}}{105.99 \text{ g}} \times 100\% = 11.3\%$$

$$\% \text{O} = \frac{48.00 \text{ g}}{105.99 \text{ g}} \times 100\% = 45.3\%$$

$\therefore$  the percentage composition is 43.4% Na, 11.3% C and 45.3% O.

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